FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)
112740-252	09/889498

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/00243	13 January 2000	18 January 1999

TITLE OF INVENTION

RESERVED CAPACITY METHOD FOR DIGITAL DATA TRANSMISSION NETWORKS AND DATA SWITCHING CENTER

APPLICANT(S) FOR DO/EO/US

Bernd Grossmann

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U S.C. 371 (c)(3))
   a. ☒ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Submission of Drawings Figures 1-6 on six sheets

U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/889498	PCT/EP00/00243	112740-252

21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1,000.00
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	$860.00
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$710.00
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$690.00
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT = $860.00

Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)). $0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	10 - 20 =	0	x $18.00	$0.00
Independent claims	2 - 3 =	0	x $80.00	$0.00
Multiple Dependent Claims **(check if applicable).**			☐	$0.00

TOTAL OF ABOVE CALCULATIONS = $860.00

Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).** ☐ $0.00

SUBTOTAL = $860.00

Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). + $0.00

TOTAL NATIONAL FEE = $860.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐ $0.00

TOTAL FEES ENCLOSED = $860.00

Amount to be: refunded	$
charged	$

☒ A check in the amount of **$860.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan (Reg. No. 39,056)
Bell, Boyd & Lloyd LLC
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Chicago, Illinois 60690

SIGNATURE

William E. Vaughan
NAME

39,056
REGISTRATION NUMBER

July 17, 2001
DATE

CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10) Applicant(s): Bernd Grossmann	Docket No. 112740-252

Serial No.	Filing Date	Examiner	Group Art Unit

Invention: **RESERVED CAPACITY METHOD FOR DIGITAL DATA TRANSMISSION NETWORKS AND DATA SWITCHING CENTER**

EL704941286US

I hereby certify that the following correspondence:

Transmittal letter to the United States Designated/Elected Office in duplicate, International application as filed, amended pages, English translation, amended pages, Preliminary Amendment/Substitute Specification, Submission of Drawings Figures 1-6 on six sheets, IDS, PTO 1449, references, search report, executed declaration, filing fee $860.00, (see attached envelope for executed assignment and fee)

(Identify type of correspondence)

is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to: The Assistant Commissioner for Patents, Washington, D.C. 20231 on

July 17, 2001
(Date)

Robert Buccieri
(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

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IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT:	Bernd Grossmann	DOCKET NO: 112740-252
SERIAL NO:		GROUP ART UNIT:
		EXAMINER:
INTERNATIONAL APPLICATION NO:		PCT/EP00/00243
INTERNATIONAL FILING DATE:		13 January 2000
INVENTION:	RESERVED CAPACITY METHOD FOR DIGITAL DATA TRANSMISSION NETWORKS AND DATA SWITCHING CENTER	

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

SPECIFICATION

TITLE

RESERVED-CAPACITY METHOD FOR DIGITAL DATA TRANSMISSION NETWORKS AND DATA SWITCHING CENTER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method for reserving transmission capacities and for selecting requests for data streams of different bandwidth to be

transmitted in digital data transmission networks having a maximum transmission rate, a particular transmission capacity being available which is less than or equal to the maximum transmission rate and, furthermore, certain bandwidths or bandwidth groups having particular data transmission rates in use. Certain data transmission rates r_i are reserved for certain bandwidths or bandwidth groups b_i, and a request for transmitting data having a particular bandwidth or bandwidth group b_j only is accepted if predetermined criteria with respect to the utilization of the data network are met. In addition, the present invention relates to a data switching center.

Description of the Prior Art

Digital data transmission networks such as, for example, digital wire-connected telecommunication networks, mobile radio networks or ATM networks, pose the problem of appropriately dividing the total data transmission capacity over various services of different bandwidth. An example of this is the ISDN (Integrated Services Digital Network) which transmits voice data traffic in parallel at 1×64 kbit/s, pure data traffic at 128 kbit/s = 2×64 kbit/s and video signals at 384 kbit/s = 6×64 kbit/s. If a number of users are simultaneously dialing in for the individual services, there must be a decision criterion according to which the requirements for data transmission of the users are regulated and the total data transmission capacity is distributed over the services and within the services of different bandwidths.

It is obvious that the type of distribution of the data transmission capacity over the individual services is an essential criterion for the effectiveness and operational reliability of the data network. The aim of the distribution criterion is that the network:

- is to operate effectively and with little blocking probability even at the edge of its design capacity;
- is to respond flexibly to different load requirements of different bandwidths;
- should be stable in the case of small deviations from its design capacity;
- a large overload at one bandwidth should not trigger any blocking of other bandwidths;

- both bandwidths of different magnitude should be treated with approximately equal chances ("fairness"); and
- the administration of the data traffic should be simple.

Different distribution criteria and algorithms can be used for largely meeting the abovementioned criteria.

For example, certain transmission channels can be unambiguously allocated to each bandwidth. This prevents any blocking of a bandwidth by another bandwidth. The disadvantage of this is that there is no flexibility for distributing the transmission capacity and, thus, an ineffective mode of operation results with changing requirements.

Another possibility lies in the entire transmission capacity being unrestrictedly available to all bandwidths up to the limit of capacity. Although this makes it possible to achieve optimum utilization, there is the possibility that the transmission of individual bandwidths is blocked by other bandwidths due to the high utilization of the data network. If a maximum capacity is reserved for each individual bandwidth in an improvement of this method, this leads to good protection against blocking between the bandwidths but to a low system efficiency.

Another possibility lies in basically providing the total transmission capacity to all bandwidths but to stop requests for transmitting data of a particular bandwidth as soon as the total available data transmission capacity drops below a certain threshold value. This method is called "sum limitation" or "trunk reservation" and is, in most cases, used together with priority allocations for certain requirements. The disadvantage of this method is that reservations are still maintained even at high overloads of certain bandwidths and, as a result, free capacity is wasted. This results in higher blocking probabilities for the other bandwidths in each case.

A method for reserving transmission capacities, and for selecting requirements for data streams of different bandwidth to be transmitted in digital data transmission networks having a maximum transmission rate, similar to the present invention, is known from European patent application EP 0 449 480 A3. In

this document, it is proposed to accept a request for transmission of data having a certain bandwidth b_j only if predetermined criteria with respect to the utilization of the data network are met. In this arrangement, various criteria are proposed, all of which relate to a dynamically varying total reserved data transmission capacity.

Furthermore, reference is made to the European Patent Application EP 0 798 942 A2 which discloses a method for reserving transmission capacities and for selecting requirements for data streams of different bandwidth to be transmitted in digital data transmission networks with a maximum transmission rate b_{max}, such that:

- a particular transmission capacity is available which is smaller than or equal to the maximum transmission rate b_{max};
- certain bandwidths or bandwidth groups b_i having data transmission rates s_i are in use;
- certain data transmission rates r_i are reserved for certain bandwidths or bandwidth groups b_i;
- a request for transmitting data having a particular bandwidth or bandwidth group b_j only is accepted if predefined criteria with respect to the utilization of the data network are met; and
- a request for transmitting data having a certain bandwidth b_j is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate r_j for the requesting bandwidth or bandwidth group b_j even after the transmission has been accepted

It is, therefore, an object of the present invention to specify another method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate with an improved and simplified criterion for the acceptance or rejection of a request for data transmission. It is a further object of the present invention to specify a data switching center which has an improved algorithm for accepting or rejecting a request for data transmission.

SUMMARY OF THE INVENTION

Accordingly, the present invention proposes to improve the known method for reserving transmission capacities and for selecting requests for data streams of different bandwidth which are to be transmitted in digital data transmission networks having a maximum transmission rate. In the case of this method, a particular transmission capacity is available which is less than or equal to the maximum transmission rate and, furthermore, certain bandwidths or bandwidth groups have particular data transmission rates in use, certain data transmission rates r_i are reserved for certain bandwidths or bandwidth groups b_i, a request for transmitting data having a particular bandwidth or bandwidth group b_j is only accepted if predetermined criteria with respect to the utilization of the data network are met, and a request for transmitting data having a certain bandwidth b_j is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate r_j for the requesting bandwidth or bandwidth group b_j, even after the transmission has been accepted. The improvement is designed such that:

- particular data transmission rates r_i (with $i = 1$ to n) are reserved for n bandwidths or bandwidth groups b_i (with $i = 1$ to n);
- threshold values p_i (with $i = 1$ to n) are established for each particular bandwidth or bandwidth group b_i;
- the loading s_i of the data transmission network with respect to the individual bandwidths b_i is observed;
- when a loading s_j of the threshold value p_j (with j element of values i) of the bandwidth or bandwidth group b_j is exceeded, the reservation of data transmission rates r_j is canceled for this bandwidth or bandwidth group b_j; and
- the request for transmitting data having this particular bandwidth or bandwidth group b_j is only accepted if the unoccupied data transmission capacity then available can still meet all reservations r_k (with $k = 1$ to $j - 1$ and $j + 1$ to n) of all remaining bandwidths

or bandwidth groups b_k with uncancelled reservations even after the request has been accepted.

An advantageous embodiment of the method of the present invention provides can consist in that the reserved data transmission rates r_i are integral multiples (with ri = n * bi and n = 0, 1, 2, ...) of the respective bandwidths or of the largest bandwidth of the respective bandwidth group b_i. The result of this measure is that no unnecessary capacity is wasted in the reserved data transmission rates r_i.

Another embodiment of the present invention provides that a second threshold value pp_i which is smaller than the first threshold value p_i is determined at least for a bandwidth b_i, and when this threshold value ppi of the data transmission load s_i utilized is reached, the value of the reserve data transmission capacity r_i is reduced.

According to the current data transmission standards, it is advantageous if the bandwidths b_i are assumed to be integral multiples of 64 kbit/s (N × 64 kbit/s).

The method according to the present invention can be advantageously used in a digital telecommunication network, especially an ISDN network, a digital mobile radio network or also in an ATM (asynchronous transfer mode) network.

According to the present invention, a data switching center is also proposed which can carry out the method represented above. Such embodiment includes microprocessor-controlled switching facilities, the programming of which exhibits algorithms according to the method according to the present invention.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a diagrammatic representation of the utilization and reservation situation of a data transmission link with no data traffic occurring;

Figure 2 shows a load situation of a data transmission network having low load;

Figure 3 shows a load situation of a data transmission network having a data traffic volume just below a maximum threshold;

Figure 4 shows a load situation of a data transmission network as in Figure 3, whereupon a further request for data transmission is made;

Figure 5 shows an effect of a transgression of a second threshold value on reserved data transmission capacity in a data transmission network; and

Figure 6 shows a load situation of the data transmission network wherein the load on first and second bandwidths is so low that reservations on first and third bandwidths are active and, at the same time, the loading by the second bandwidth is so great that there is no more associated reservation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 diagrammatically shows the utilization and reservation situation of a data transmission link in which there is no data traffic taking place. Along the ordinate, the data transmission capacity is plotted in integral multiples of 64 kbit/s and along the abscissa, the total capacity of the data transmission system is shown in a bar chart, the individual reserved data transmission capacities r_1 to r_3 being shown shaded within the total capacity. Adjacently to the right of that, the transmission capacities utilized and reserved by the individual bandwidths b_1 to b_3 are set up.

Three bandwidths b_1 with one times 64 kbit/s, b_2 with twice 64 kbit/s and b_3 with six times 64 kbit/s are again shown separately, by way of example. Since there is no data traffic in the present case, the bars above the corresponding bandwidths in each case consist only of the reserved data transmission capacity r_1 to r_3. In addition, the magnitude of the fixed threshold values p_1 to p_3 is drawn allocated to the corresponding bandwidths and the second threshold value pp_3 is drawn for bandwidth b_3.

In addition, the shading relationships are shown in this and in all other figures, and below these the numerical values of the corresponding bars are shown in a table.

Figure 2 shows a load situation of the data transmission network with low load. The left-hand bar shows the total data transmission capacity as it is divided into the utilized areas s_1 to s_3 and the reserved areas r_1 to r_3 of the individual bandwidths and an additional free data transmission capacity which is available for everyone. On the right-hand side, the corresponding divisions are allocated to the individual bandwidths b_1 to b_3. In the bandwidths, the individual data transmission capacities s_1 to s_3 used are in each case shown, and the reserved data transmission capacity r_1 to r_3 allocated to the respective bandwidth. In addition, the predetermined threshold values p_1 to p_3 are specified for the individual bandwidths. Also, a second threshold value pp_2, starting from which the reserved data transmission capacity of this bandwidth decreases, is also shown at bandwidth b_2. All bandwidths are utilized to a relatively low degree so that the sum of the reserved bandwidths r_1 to r_3 is much smaller than the free data transmission capacity accessible to all bandwidths. The threshold p_i is not reached in any bandwidth and there is no protective mechanism in force. Thus, new requests for data transmission can be accepted without restriction.

Figure 3 shows a load situation of the data transmission network in which a data traffic volume which is just below the threshold p_2 already exists in bandwidth b_2. If a further request for data transmission is made for this bandwidth b_2, a situation as shown in Figure 4 results in accordance with the present invention. Although the request for b_2 has been accepted here since the magnitude of the total unused data transmission capacity is greater than the sum of the reserved data transmission capacities r_1 and r_3 of the other bandwidths, the reserved data transmission capacity r_2 is canceled since the threshold p_2 has been exceeded for b_2, and thus additional freely available data transmission capacity is provided.

In Figure 5, finally, the effect of a transgression of the second threshold value pp_3 (if such a threshold value has been determined) on the reserved data transmission capacity r_3 is shown via bandwidth b_3. When this threshold value pp_3 is exceeded, the reserved data transmission capacity r_3 is reduced by a certain factor, by one half in this case. Due to this reduction of the reserved capacities, the

freely available area is correspondingly increased and provides slightly more free data transmission capacity for all bandwidths in situations of high loading.

Although the load situation of the data transmission network is already relatively high in Figures 3-5 and the reservations for the data transmission capacity have been partially canceled, requests for data transmission can still be accepted for all bandwidths since, in spite of the additional transmission, the unused capacity of the data transmission network still remains greater than the reserved capacities of the other bandwidths. However, this situation changes with a load situation as shown in Figure 6. The load on the bandwidths b_1 and b_2 is so low in this case that reservations r_1 and r_3 are active. At the same time, the loading by bandwidth b_2 is so great that there is no more reservation in this case. In addition, the free data transmission capacity has shrunk greatly due to the high utilization rate.

According to the present invention, a request for further data transmission with bandwidth b_2 is rejected under this load situation since the sum of r_1 and r_3 would be greater than the unused capacity then still remaining with an imagined acceptance of the request.

Another request for further data transmission with bandwidth b_1 would be accepted since the sum of r_2 and r_3 (r_2 having the value 0 since this reservation has already been canceled) would be less than the unused capacity then still remaining with an imagined acceptance of this request. Similarly, a possible request for data transmission with bandwidth b_3 would be accepted on the basis of the same criteria.

Overall, the method of the present invention with, respectively, a switching center equipped to carry out this method, has the result that the data transmission network operates effectively and with little blocking probability even at the edge of its design capacity. In addition, it responds flexibly to different load requirements of different bandwidths, is stable in the case of small deviations from its design capacity, does not trigger any blocking of other bandwidths with a large overload of one bandwidth, both treats bandwidths of different magnitude with approximately equal chances, i.e. behaves "fairly", and, finally, allows very simple administration of the data traffic due to the simple algorithm.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

A method, and data switching center, for reserving transmission capacities and for selecting requests for data streams of different bandwidth to be transmitted in digital data transmission networks. The method and the data switching center are characterized by the fact that a request for transmitting data having a certain bandwidth is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate for the requesting bandwidth or bandwidth group, even after the transmission has been accepted.

In the claims:

On page 11, cancel line 1, and substitute the following left-hand justified heading therefor:

I Claim as My Invention:

Please cancel claims 1-10, without prejudice, and substitute the following claims therefor:

11. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate, the method comprising the steps of:

making available a particular transmission capacity which is less than or equal to the maximum transmission rate;

reserving particular data transmission rates for particular bandwidths or bandwidth groups;

establishing threshold values for each of the particular bandwidths or bandwidth groups;

effecting a loading of a data transmission network with respect to the particular bandwidths or bandwidth groups;

canceling a reservation of data transmission rates for the particular bandwidth or bandwidth group when a loading of the threshold value of the particular bandwidth or bandwidth group is exceeded; and

accepting a request for transmitting data having the particular bandwidth or bandwidth group only if an unoccupied data transmission capacity then available can still meet all reservations of all remaining bandwidths or bandwidth groups with uncancelled reservations even after the request has been accepted.

12. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 11, wherein the reserved data transmission rates are integral multiplies of, respectively, the particular bandwidth or a greatest bandwidth of the particular bandwidth group.

13. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 11, wherein upon acceptance of the request for transmission, a reserved area of the data transmission rate is occupied, at least partially, if there is no other free data transmission capacity available.

14. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 13, wherein if a reserved data transmission capacity is completely utilized, no further requests for transmitting data having this particular bandwidth or bandwidth group are accepted.

15. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 11, further comprising the steps of:

determining a second threshold value which is smaller than the first threshold value for a particular bandwidth;

reducing a value of reserved data transmission capacity when the second threshold value of the data transmission load is reached.

16. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 11, wherein the particular bandwidths are integral multiples of 64 kbit/s.

17. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 11, wherein the data transmission network is an ISDN digital telecommunication network.

18. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 11, wherein the data transmission network is a digital mobile radio network.

19. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate as claimed in claim 11, wherein the data transmission network is an ATM network.

20. A data switching center for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate, the data switching center comprising:

means for making available a particular transmission capacity which is less than or equal to the maximum transmission rate;

means for reserving particular data transmission rates for particular bandwidths or bandwidth groups;

means for establishing threshold values for each of the particular bandwidths or bandwidth groups;

means for effecting a loading of a data transmission network with respect to the particular bandwidths or bandwidth groups;

means for canceling a reservation of data transmission rates for a particular bandwidth or bandwidth group when a loading of the threshold value of the particular bandwidth or bandwidth group is exceeded; and

means for accepting a request for transmitting data having the particular bandwidth or bandwidth group only if an unoccupied data transmission capacity then available can still meet all reservations of all remaining bandwidths or bandwidth groups with uncancelled reservations even after the request has been accepted.

REMARKS

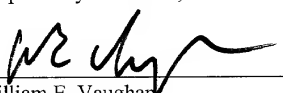
The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes Made**".

In addition, the present amendment cancels original claims 1-10 in favor of new claims 11-20. Claims 11-20 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-10 in

order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§103, 102, 103 or 112. Indeed, the cancellation of claims 1-10 does not constitute an intent on the part of the Applicant to surrender any of the subject matter of claims 1-10.

Early consideration on the merits is respectfully requested.

Respectfully submitted,



(Reg. No. 39,056)

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Chicago, Illinois 60690-1135
(312) 807-4292
Attorneys for Applicant

VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

SPECIFICATION

TITLE

~~Reserved capacity method for digital data transmission networks and data switching center~~

RESERVED CAPACITY METHOD FOR DIGITAL DATA TRANSMISSION NETWORKS AND DATA SWITCHING CENTER

BACKGROUND OF THE INVENTION

~~Description~~

Field of the Invention

The present invention relates to a method for reserving transmission capacities and for selecting requests for data streams of different bandwidth to be transmitted in digital data transmission networks having a maximum transmission rate, a particular transmission capacity being available which is less than or equal to the maximum transmission rate and, furthermore, certain bandwidths or bandwidth groups having particular data transmission rates in use~~, certain~~. Certain data transmission rates r_i ~~being~~ are reserved for certain bandwidths or bandwidth groups b_i, and a request for transmitting data having a particular bandwidth or bandwidth group b_j only ~~being~~ is accepted if predetermined criteria with respect to the utilization of the data network are met. In addition, the present invention relates to a data switching center.

Description of the Prior Art

Digital data transmission networks such as, for example, digital wire-connected telecommunication networks, mobile radio networks or ATM networks, pose the problem of appropriately dividing the total data transmission capacity over various services of different bandwidth. An example of this is the ISDN (Integrated Services Digital Network) which transmits voice data traffic in parallel at

1 × 64 kbit/s, pure data traffic at 128 kbit/s = 2 × 64 kbit/s and video signals at 384 kbit/s = 6 × 64 kbit/s. If a number of users are simultaneously dialing in for the individual services, there must be a decision criterion according to which the requirements for data transmission of the users are regulated and the total data transmission capacity is distributed over the services and within the services of different bandwidths.

It is obvious that the type of distribution of the data transmission capacity over the individual services is an essential criterion for the effectiveness and operational reliability of the data network. The aim of the distribution criterion is that the network:

- is to operate effectively and with little blocking probability even at the edge of its design capacity;
- is to respond flexibly to different load requirements of different bandwidths;
- should be stable in the case of small deviations from its design capacity;
- a large overload at one bandwidth should not trigger any blocking of other bandwidths;
- both bandwidths of different magnitude should be treated with approximately equal chances ("fairness"); and
- the administration of the data traffic should be simple.

Different distribution criteria and algorithms can be used for largely meeting the abovementioned criteria.

For example, certain transmission channels can be unambiguously allocated to each bandwidth. This prevents any blocking of a bandwidth by another bandwidth. The disadvantage of this is that there is no flexibility for distributing the transmission capacity and, thus, an ineffective mode of operation results with changing requirements.

Another possibility ~~consists in that~~ lies in the entire transmission capacity ~~is~~ being unrestrictedly available to all bandwidths up to the limit of capacity. Although this makes it possible to achieve optimum utilization, there is the possibility that the transmission of individual bandwidths is blocked by other

bandwidths due to the high utilization of the data network. If a maximum capacity is reserved for each individual bandwidth in an improvement of this method, this leads to good protection against blocking between the bandwidths but to a low system efficiency.

Another possibility ~~consists~~ lies in basically providing the total transmission capacity to all bandwidths but to stop requests for transmitting data of a particular bandwidth as soon as the total available data transmission capacity drops below a certain threshold value. This method is called "sum limitation" or "trunk reservation" and is, in most cases, used together with priority allocations for certain requirements. The disadvantage of this method is that reservations are still maintained even at high overloads of certain bandwidths and, as a result, free capacity is wasted. This results in higher blocking probabilities for the other bandwidths in each case.

A method for reserving transmission capacities, and for selecting requirements for data streams of different bandwidth to be transmitted in digital data transmission networks having a maximum transmission rate, similar to the present invention, is known from European patent application EP 0 449 480 A3. In this document, it is proposed to accept a request for transmission of data having a certain bandwidth b_j only if predetermined criteria with respect to the utilization of the data network are met. In this arrangement, various criteria are proposed, all of which relate to a dynamically varying total reserved data transmission capacity.

Furthermore, reference is made to the European Patent Application EP 0 798 942 A2 which discloses a method for reserving transmission capacities and for selecting requirements for data streams of different bandwidth to be transmitted in digital data transmission networks with a maximum transmission rate b_{max}, such that:

- a particular transmission capacity ~~being~~ is available which is smaller than or equal to the maximum transmission rate b_{max}~~;~~
- certain bandwidths or bandwidth groups b_i having data transmission rates s_i are in use~~;~~

- certain data transmission rates r_i ~~being~~ are reserved for certain bandwidths or bandwidth groups b_i;
- a request for transmitting data having a particular bandwidth or bandwidth group b_j only ~~being~~ is accepted if predefined criteria with respect to the utilization of the data network are met~~,~~; and
- ~~in which~~ a request for transmitting data having a certain bandwidth b_j is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate r_j for the requesting bandwidth or bandwidth group b_j even after the transmission has been accepted.

It is ~~the~~ , therefore, an object of the present invention to specify another method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate with an improved and simplified criterion for the acceptance or rejection of a request for data transmission. It is ~~also the~~ a further object of the present invention to specify a data switching center which has an improved algorithm for accepting or rejecting a request for data transmission.

SUMMARY OF THE INVENTION

Accordingly, ~~the inventor~~ the present invention proposes to improve the known method for reserving transmission capacities and for selecting requests for data streams of different bandwidth which are to be transmitted in digital data transmission networks having a maximum transmission rate~~, in~~ . In the case of ~~which~~ this method, a particular transmission capacity is available which is less than or equal to the maximum transmission rate and, furthermore, certain bandwidths or bandwidth groups have particular data transmission rates in use, certain data transmission rates r_i are reserved for certain bandwidths or bandwidth groups b_i, a request for transmitting data having a particular bandwidth or bandwidth group b_j is only accepted if predetermined criteria with respect to the utilization of the data network are met, and a request for transmitting data having a certain bandwidth b_j is

accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate r_j for the requesting bandwidth or bandwidth group b_j, even after the transmission has been accepted~~, to the extent~~ . The improvement is designed such that:

- particular data transmission rates r_i (with i = 1 to n) are reserved for n bandwidths or bandwidth groups b_i (with i = 1 to n)~~;~~;
- threshold values p_i (with i = 1 to n) are established for each particular bandwidth or bandwidth group b_i~~;~~;
- the loading s_i of the data transmission network with respect to the individual bandwidths b_i is observed~~;~~; ~~and,~~
- when a loading s_j of the threshold value p_j (with j element of values i) of the bandwidth or bandwidth group b_j is exceeded, the reservation of data transmission rates r_j is canceled for this bandwidth or bandwidth group b_j~~;~~; and
- the request for transmitting data having this particular bandwidth or bandwidth group b_j is only accepted if the unoccupied data transmission capacity then available can still meet all reservations r_k (with k = 1 to j - 1 and j + 1 to n) of all remaining bandwidths or bandwidth groups b_k with uncancelled reservations even after the request has been accepted.

An advantageous embodiment of the method of the present invention provides can consist in that the reserved data transmission rates r_i are integral multiples (with ri = n * bi and n = 0, 1, 2, ...) of the respective bandwidths or of the largest bandwidth of the respective bandwidth group b_i. The result of this measure is that no unnecessary capacity is wasted in the reserved data transmission rates r_i.

Another ~~improvement of the concept according to~~ embodiment of the present invention ~~consists in~~ provides that a second threshold value pp_i which is smaller than the first threshold value p_i is determined at least for a bandwidth b_i,

and when this threshold value ppi of the data transmission load s_i utilized is reached, the value of the reserve data transmission capacity r_i is reduced.

According to the current data transmission standards, it is advantageous if the bandwidths b_i are assumed to be integral multiples of 64 kbit/s ($N \times 64$ kbit/s).

The method according to the present invention can be advantageously used in a digital telecommunication network, especially an ISDN network, a digital mobile radio network or also in an ATM (asynchronous transfer mode) network.

According to the present invention, a data switching center is also proposed which~~, to achieve the object of the invention, has means which~~ can carry out the method represented above. ~~These means essentially consist of~~ Such embodiment includes microprocessor-controlled switching facilities, the programming of which exhibits algorithms according to the method according to the present invention.

~~Further embodiments, additional features and advantages of the invention are obtained from the subsequent description of a preferred exemplary embodiment, referring to the drawings, and from the subclaims.~~

~~In the text which follows, the invention will be explained in further detail, referring to a drawing, in which:~~

~~Figure 1-6 is a diagrammatic representation of different load situations of a data transmission network.~~

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a diagrammatic representation of the utilization and reservation situation of a data transmission link with no data traffic occurring;

Figure 2 shows a load situation of a data transmission network having low load;

Figure 3 shows a load situation of a data transmission network having a data traffic volume just below a maximum threshold;

Figure 4 shows a load situation of a data transmission network as in Figure 3, whereupon a further request for data transmission is made;

Figure 5 shows an effect of a transgression of a second threshold value on reserved data transmission capacity in a data transmission network; and

Figure 6 shows a load situation of the data transmission network wherein the load on first and second bandwidths is so low that reservations on first and third bandwidths are active and, at the same time, the loading by the second bandwidth is so great that there is no more associated reservation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 diagrammatically shows the utilization and reservation situation of a data transmission link in which there is no data traffic taking place. Along the ordinate, the data transmission capacity is plotted in integral multiples of 64 kbit/s and along the abscissa, the total capacity of the data transmission system is shown in a bar chart, the individual reserved data transmission capacities r_1 to r_3 being shown shaded within the total capacity. Adjacently to the right of that, the transmission capacities utilized and reserved by the individual bandwidths b_1 to b_3 are set up.

Three bandwidths b_1 with one times 64 kbit/s, b_2 with twice 64 kbit/s and b_3 with six times 64 kbit/s are again shown separately, by way of example. Since there is no data traffic in the present case, the bars above the corresponding bandwidths in each case consist only of the reserved data transmission capacity r_1 to r_3. In addition, the magnitude of the fixed threshold values p_1 to p_3 is drawn allocated to the corresponding bandwidths and the second threshold value pp_3 is drawn for bandwidth b_3.

In addition, the shading relationships are shown in this and in all other figures, and below these the numerical values of the corresponding bars are shown in a table.

Figure 2 shows a load situation of the data transmission network with low load. The left-hand bar shows the total data transmission capacity as it is divided into the utilized areas s_1 to s_3 and the reserved areas r_1 to r_3 of the individual

bandwidths and an additional free data transmission capacity which is available for everyone. On the right-hand side, the corresponding divisions are allocated to the individual bandwidths b_1 to b_3. In the bandwidths, the individual data transmission capacities s_1 to s_3 used are in each case shown, and the reserved data transmission capacity r_1 to r_3 allocated to the respective bandwidth. In addition, the predetermined threshold values p_1 to p_3 are specified for the individual bandwidths. ~~In addition~~ Also, a second threshold value pp_2, starting from which the reserved data transmission capacity of this bandwidth decreases, is also shown at bandwidth b_2. All bandwidths are utilized to a relatively low degree so that the sum of the reserved bandwidths r_1 to r_3 is much smaller than the free data transmission capacity accessible to all bandwidths. The threshold p_i is not reached in any bandwidth and there is no protective mechanism in force. Thus, new requests for data transmission can be accepted without restriction.

Figure 3 shows a load situation of the data transmission network in which a data traffic volume which is just below the threshold p_2 already exists in bandwidth b_2. If ~~then~~ a further request for data transmission is made for this bandwidth b_2, a situation as shown in ~~figure~~ Figure 4 results in accordance with the present invention. Although the request for b_2 has been accepted here since the magnitude of the total unused data transmission capacity is greater than the sum of the reserved data transmission capacities r_1 and r_3 of the other bandwidths, the reserved data transmission capacity r_2 is canceled since the threshold p_2 has been exceeded for b_2, and thus additional freely available data transmission capacity is provided.

In ~~figure~~ Figure 5, finally, the effect of a transgression of the second threshold value pp_3 (if such a threshold value has been determined) on the reserved data transmission capacity r_3 is shown ~~by means of~~ via bandwidth b_3. When this threshold value pp_3 is exceeded ~~as shown in this figure~~, the reserved data transmission capacity r_3 is reduced by a certain factor, by one half in this case. Due to this reduction of the reserved capacities, the freely available area is correspondingly increased and provides slightly more free data transmission capacity for all bandwidths in situations of high loading.

Although the load situation of the data transmission network is already relatively high in ~~figures~~ Figures 3-5 and the reservations for the data transmission capacity have been partially canceled, requests for data transmission can still be accepted for all bandwidths since, in spite of the additional transmission, the unused capacity of the data transmission network still remains greater than the reserved capacities of the other bandwidths ~~in each case~~. However, this situation changes with a load situation as shown in ~~figure~~ Figure 6. The load on the bandwidths b_1 and b_2 is so low in this case that reservations r_1 and r_3 are active. At the same time, the loading by bandwidth b_2 is so great that there is no more reservation in this case. In addition, the free data transmission capacity has shrunk greatly due to the high utilization rate.

According to the ~~concept of~~ the present invention, a request for further data transmission with bandwidth b_2 is rejected under this load situation since the sum of r_1 and r_3 would be greater than the unused capacity then still remaining with an imagined acceptance of the request.

Another request for further data transmission with bandwidth b_1 would be accepted since the sum of r_2 and r_3 (r_2 having the value 0 since this reservation has already been canceled) would be less than the unused capacity then still remaining with an imagined acceptance of this request. Similarly, a possible request for data transmission with bandwidth b_3 would be accepted on the basis of the same criteria.

Overall, the method ~~according to~~ of the present invention with, respectively, a switching center equipped ~~with means for carrying~~ to carry out this method, has the result that the data transmission network operates effectively and with little blocking probability even at the edge of its design capacity~~.~~, In addition, it responds flexibly to different load requirements of different bandwidths, is stable in the case of small deviations from its design capacity, does not trigger any blocking of other bandwidths with a large overload of one bandwidth, both treats bandwidths of different magnitude with approximately equal chances, i.e. behaves "fairly", and, finally, allows very simple administration of the data traffic due to the simple algorithm.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

~~Abstract~~

ABSTRACT OF THE DISCLOSURE

~~Reserved capacity method for digital data transmission networks and data switching center~~

~~The invention relates to a~~ A method, and data switching center, for reserving transmission capacities and for selecting requests for data streams of different bandwidth to be transmitted in digital data transmission networks. ~~The invention also relates to a data switching center.~~ The method and the data switching center are characterized by the fact that a request for transmitting data having a certain bandwidth is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate for the requesting bandwidth or bandwidth group, even after the transmission has been accepted.

Description

Reserved-capacity method for digital data transmission networks and data switching center

The invention relates to a method for reserving transmission capacities and for selecting requests for data streams of different bandwidth to be transmitted in digital data transmission networks having a maximum transmission rate, a particular transmission capacity being available which is less than or equal to the maximum transmission rate and, furthermore, certain bandwidths or bandwidth groups having particular data transmission rates in use, certain data transmission rates r_i being reserved for certain bandwidths or bandwidth groups b_i, and a request for transmitting data having a particular bandwidth or bandwidth group b_j only being accepted if predetermined criteria with respect to the utilization of the data network are met. In addition, the invention relates to a data switching center.

Digital data transmission networks such as, for example, digital wire-connected telecommunication networks, mobile radio networks or ATM networks, pose the problem of appropriately dividing the total data transmission capacity over various services of different bandwidth. An example of this is the ISDN (Integrated Services Digital Network) which transmits voice data traffic in parallel at 1 × 64 kbit/s, pure data traffic at 128 kbit/s = 2 × 64 kbit/s and video signals at 384 kbit/s = 6 × 64 kbit/s. If a number of users are simultaneously dialing in for the individual services, there must be a decision criterion according to which the requirements for data transmission of the users are regulated and the total data transmission

capacity is distributed over the services and within the services of different bandwidths.

It is obvious that the type of distribution of the data transmission capacity over the individual services is an essential criterion for the effectiveness and operational reliability of the data network. The aim of the distribution criterion is that the network:
- is to operate effectively and with little blocking probability even at the edge of its design capacity
- is to respond flexibly to different load requirements of different bandwidths
- should be stable in the case of small deviations from its design capacity
- a large overload at one bandwidth should not trigger any blocking of other bandwidths
- both bandwidths of different magnitude should be treated with approximately equal chances ("fairness") and
- the administration of the data traffic should be simple.

Different distribution criteria and algorithms can be used for largely meeting the abovementioned criteria.

For example, certain transmission channels can be unambiguously allocated to each bandwidth. This prevents any blocking of a bandwidth by another bandwidth. The disadvantage of this is that there is no flexibility for distributing the transmission capacity and thus an ineffective mode of operation results with changing requirements.

Another possibility consists in that the entire transmission capacity is unrestrictedly available to all bandwidths up to the limit of capacity. Although this makes it possible to achieve optimum utilization, there is the possibility that the transmission of

individual bandwidths is blocked by other bandwidths due to the high utilization of the data network. If a maximum capacity is reserved for each individual bandwidth in an improvement of this

method, this leads to good protection against blocking between the bandwidths but to a low system efficiency.

Another possibility consists in basically providing the total transmission capacity to all bandwidths but to stop requests for transmitting data of a particular bandwidth as soon as the total available data transmission capacity drops below a certain threshold value. This method is called "sum limitation" or "trunk reservation" and is in most cases used together with priority allocations for certain requirements. The disadvantage of this method is that reservations are still maintained even at high overloads of certain bandwidths and, as a result, free capacity is wasted. This results in higher blocking probabilities for the other bandwidths in each case.

A method for reserving transmission capacities, and for selecting requirements for data streams of different bandwidth to be transmitted in digital data transmission networks having a maximum transmission rate, similar to the invention, is known from European patent application EP 0 449 480 A3. In this document, it is proposed to accept a request for transmission of data having a certain bandwidth b_j only if predetermined criteria with respect to the utilization of the data network are met. In this arrangement, various criteria are proposed, all of which relate to a dynamically varying total reserved data transmission capacity.

Furthermore, reference is made to the European Patent Application EP 0 798 942 A2 which discloses a method for reserving transmission capacities and for selecting requirements for data streams of different bandwidth

to be transmitted

in digital data transmission networks with a maximum transmission rate b_{max},

- a particular transmission capacity being available which is smaller than or equal to the maximum transmission rate b_{max},
- certain bandwidths or bandwidth groups b_i having data transmission rates s_i in use,
- certain data transmission rates r_i being reserved for certain bandwidths or bandwidth groups b_i,
- a request for transmitting data having a particular bandwidth or bandwidth group b_j only being accepted if predefined criteria with respect to the utilization of the data network are met,
- in which a request for transmitting data having a certain bandwidth b_j is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate r_j for the requesting bandwidth or bandwidth group b_j even after the transmission has been accepted.

It is the object of the invention to specify another method for reserving transmission capacities and for selecting requests for data streams of different bandwidths to be transmitted in digital data transmission networks having a maximum transmission rate with an improved and simplified criterion for the acceptance or rejection of a request for data transmission. It is also the object of the invention to specify a data switching center which has an improved algorithm for accepting or rejecting a request for data transmission.

Accordingly, the inventor proposes to improve the known method for reserving transmission capacities and for

selecting requests for data streams of different bandwidth which are to be transmitted in digital

data transmission networks having a maximum transmission rate, in the case of which method a particular transmission capacity is available which is less than or equal to the maximum transmission rate and, furthermore, certain bandwidths or bandwidth groups have particular data transmission rates in use, certain data transmission rates r_i are reserved for certain bandwidths or bandwidth groups b_i, a request for transmitting data having a particular bandwidth or bandwidth group b_j is only accepted if predetermined criteria with respect to the utilization of the data network are met, and a request for transmitting data having a certain bandwidth b_j is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate r_j for the requesting bandwidth or bandwidth group b_j, even after the transmission has been accepted, to the extent that:

- particular data transmission rates r_i (with $i = 1$ to n) are reserved for n bandwidths or bandwidth groups b_i (with $i = 1$ to n),
- threshold values p_i (with $i = 1$ to n) are established for each particular bandwidth or bandwidth group b_i,
- the loading s_i of the data transmission network with respect to the individual bandwidths b_i is observed, and,
- when a loading s_j of the threshold value p_j (with j element of values i) of the bandwidth or bandwidth group b_j is exceeded, the reservation of data transmission rates r_j is canceled for this bandwidth or bandwidth group b_j, and
- the request for transmitting data having this particular bandwidth or bandwidth group b_j is only

accepted if the unoccupied data transmission capacity then available can still meet all reservations r_k (with k = 1 to j - 1 and j + 1 to n) of all remaining bandwidths

or bandwidth groups b_k with uncanceled reservations even after the request has been accepted.

An advantageous embodiment of the method can consist in that the reserved data transmission rates r_i are integral multiples (with ri = n * bi and n = 0, 1, 2, ...) of the respective bandwidths or of the largest bandwidth of the respective bandwidth group b_i. The result of this measure is that no unnecessary capacity is wasted in the reserved data transmission rates r_i.

Another improvement of the concept according to the invention consists in that a second threshold value pp_i which is smaller than the first threshold value p_i is determined at least for a bandwidth b_i, and when this threshold value ppi of the data transmission load s_i utilized is reached, the value of the reserve data transmission capacity r_i is reduced.

According to the current data transmission standards, it is advantageous if the bandwidths b_i are assumed to be integral multiples of 64 kbit/s (N × 64 kbit/s).

The method according to the invention can be advantageously used in a digital telecommunication network, especially an ISDN network, a digital mobile radio network or also in an ATM (asynchronous transfer mode) network.

According to the invention, a data switching center is also proposed which, to achieve the object of the invention, has means which carry out the method represented above. These means essentially consist of

microprocessor-controlled switching facilities, the programming of which exhibits algorithms according to the method according to the invention.

Further embodiments, additional features and advantages of the invention are obtained from the subsequent description of a preferred exemplary embodiment, referring to the drawings, and from the subclaims.

In the text which follows, the invention will be explained in further detail, referring to a drawing, in which:

Figure 1-6 is a diagrammatic representation of different load situations of a data transmission network.

Figure 1 diagrammatically shows the utilization and reservation situation of a data transmission link in which there is no data traffic taking place. Along the ordinate, the data transmission capacity is plotted in integral multiples of 64 kbit/s and along the abscissa, the total capacity of the data transmission system is shown in a bar chart, the individual reserved data transmission capacities r_1 to r_3 being shown shaded within the total capacity. Adjacently to the right of that, the transmission capacities utilized and reserved by the individual bandwidths b_1 to b_3 are set up.

Three bandwidths b_1 with one times 64 kbit/s, b_2 with twice 64 kbit/s and b_3 with six times 64 kbit/s are again shown separately by way of example. Since there is no data traffic in the present case, the bars above the corresponding bandwidths in each case consist only of the reserved data transmission capacity r_1 to r_3. In addition, the magnitude of the fixed threshold values p_1 to p_3 is drawn allocated to the corresponding bandwidths and the second threshold value pp_3 is drawn for bandwidth b_3.

In addition, the shading relationships are shown in this and in all other figures and below these the numerical values of the corresponding bars are shown in a table.

Figure 2 shows a load situation of the data transmission network with low load. The left-hand bar shows the total data transmission capacity as it is divided into the utilized areas s_1 to s_3 and the reserved areas r_1 to r_3 of the individual bandwidths and an additional free data transmission capacity which is available for everyone. On the right-hand side, the corresponding divisions are allocated to the individual bandwidths b_1 to b_3. In the bandwidths, the individual data transmission capacities s_1 to s_3 used are in each case shown, and the reserved data transmission capacity r_1 to r_3 allocated to the respective bandwidth. In addition, the predetermined threshold values p_1 to p_3 are specified for the individual bandwidths. In addition, a second threshold value pp_2, starting from which the reserved data transmission capacity of this bandwidth decreases, is also shown at bandwidth b_2. All bandwidths are utilized to a relatively low degree so that the sum of the reserved bandwidths r_1 to r_3 is much smaller than the free data transmission capacity accessible to all bandwidths. The threshold p_i is not reached in any bandwidth and there is no protective mechanism in force. Thus, new requests for data transmission can be accepted without restriction.

Figure 3 shows a load situation of the data transmission network in which a data traffic volume which is just below the threshold p_2 already exists in bandwidth b_2. If then a further request for data transmission is made for this bandwidth b_2, a situation as shown in figure 4 results in accordance with the invention. Although the request for b_2 has been accepted here since the magnitude of the total unused data transmission capacity is greater than the sum of the reserved data transmission capacities r_1 and r_3 of

the other bandwidths, the reserved data transmission capacity r_2 is canceled since the threshold p_2 has been exceeded for b_2,

and thus additional freely available data transmission capacity is provided.

In figure 5, finally, the effect of a transgression of the second threshold value pp_3 - if such a threshold value has been determined - on the reserved data transmission capacity r_3 is shown by means of bandwidth b_3. When this threshold value pp_3 is exceeded as shown in this figure, the reserved data transmission capacity r_3 is reduced by a certain factor, by one half in this case. Due to this reduction of the reserved capacities, the freely available area is correspondingly increased and provides slightly more free data transmission capacity for all bandwidths in situations of high loading.

Although the load situation of the data transmission network is already relatively high in figures 3-5 and the reservations for the data transmission capacity have been partially canceled, requests for data transmission can still be accepted for all bandwidths since, in spite of the additional transmission, the unused capacity of the data transmission network still remains greater than the reserved capacities of the other bandwidths in each case. However, this situation changes with a load situation as shown in figure 6. The load on the bandwidths b_1 and b_2 is so low in this case that reservations r_1 and r_3 are active. At the same time, the loading by bandwidth b_2 is so great that there is no more reservation in this case. In addition, the free data transmission capacity has shrunk greatly due to the high utilization rate.

According to the concept of the invention, a request for further data transmission with bandwidth b_2 is

rejected under this load situation since the sum of r_1 and

r_3 would be greater than the unused capacity then still remaining with an imagined acceptance of the request.

Another request for further data transmission with bandwidth b_1 would be accepted since the sum of r_2 and $r_3 - r_2$ having the value 0 since this reservation has already been canceled - would be less than the unused capacity then still remaining with an imagined acceptance of this request. Similarly, a possible request for data transmission with bandwidth b_3 would be accepted on the basis of the same criteria.

Overall, the method according to the invention with, respectively, a switching center equipped with means for carrying out this method, has the result that the data transmission network operates effectively and with little blocking probability even at the edge of its design capacity, responds flexibly to different load requirements of different bandwidths, is stable in the case of small deviations from its design capacity, does not trigger any blocking of other bandwidths with a large overload of one bandwidth, both treats bandwidths of different magnitude with approximately equal chances, i.e. behaves "fairly", and, finally, allows very simple administration of the data traffic due to the simple algorithm.

Patent claims

1. A method for reserving transmission capacities and for selecting requests for data streams of different bandwidth to be transmitted in digital data transmission networks having a maximum transmission rate b_{max},

1.1 a particular transmission capacity being available which is less than or equal to the maximum transmission rate b_{max},

1.2 certain bandwidths or bandwidth groups b_i having data transmission rates s_i in use,

1.3 certain data transmission rates r_i being reserved for certain bandwidths or bandwidth groups b_i, and

1.4 a request for transmitting data having a particular bandwidth or bandwidth group b_j only being accepted if predetermined criteria with respect to the utilization of the data network are met, and

1.5 a request for transmitting data having a certain bandwidth b_j is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate r_j for the requesting bandwidth or bandwidth group b_j, even after the transmission has been accepted,

characterized in that the following method steps are included:

1.6 particular data transmission rates r_i - with i = 1 to n - are reserved for n bandwidths or bandwidth groups b_i - with i = 1 to n - ,

1.7 threshold values p_i - with I = 1 to n - are established for each particular bandwidth or bandwidth group b_i,

1.8 the loading s_i of the data transmission network with respect to the individual bandwidths b_i is observed, and,

1.9 when a loading s_j of the threshold value p_j - with j element of values i - of the

bandwidth or bandwidth group b_j is exceeded, the reservation of data transmission rates r_j is cancelled for this bandwidth or bandwidth group b_j, and

1.10 the request for transmitting data having this particular bandwidth or bandwidth group b_j is only accepted if the unoccupied data transmission capacity then available can still meet all reservations r_k - with k = 1 to j - 1 and j + 1 to n - of all remaining bandwidths or bandwidth groups b_k with uncanceled reservations even after the request has been accepted.

2. The method as claimed in claim 1, characterized in that the reserved data transmission rates r_i are integral multiples - with $r_i = n * b_i$ and n = 0, 1, 2, ... - of the respective bandwidths or of the largest bandwidth of the respective bandwidth group b_i.

3. The method as claimed in one of claims 1-2, characterized in that, in the case of an acceptance of a request for transmission of data having this particular bandwidth or bandwidth group b_j, the reserved area of the data transmission rate r_j is occupied or partially occupied if there is no other free data transmission capacity available any more.

4. The method as claimed in claim 3, characterized in that, in the case of complete utilization of a reserved data transmission capacity r_j, no further requests for transmitting data having this bandwidth or bandwidth group b_j are accepted.

5. The method as claimed in one of claims 1-4, characterized in that, at least for a bandwidth b_i, a second threshold value pp_i which is smaller

than the first threshold value p_i is determined at least for a bandwidth b_i, and when this threshold value ppi of the data transmission load s_i utilized is reached, the value of the reserve data transmission capacity r_i is reduced.

6. The method as claimed in one of claims 1-5, characterized in that the bandwidths b_i are integral multiples of 64 kbit/s.

7. The method as claimed in one of claims 1-6, characterized in that the data transmission network is a digital telecommunication network, especially an ISDN network.

8. The method as claimed in one of claims 1-6, characterized in that the data transmission network is a digital mobile radio network.

9. The method as claimed in one of claims 1-6, characterized in that the data transmission network is an ATM network.

10. A data switching center, characterized in that it exhibits means for carrying out the method as claimed in one of claims 1-9.

GR 99 P 1064

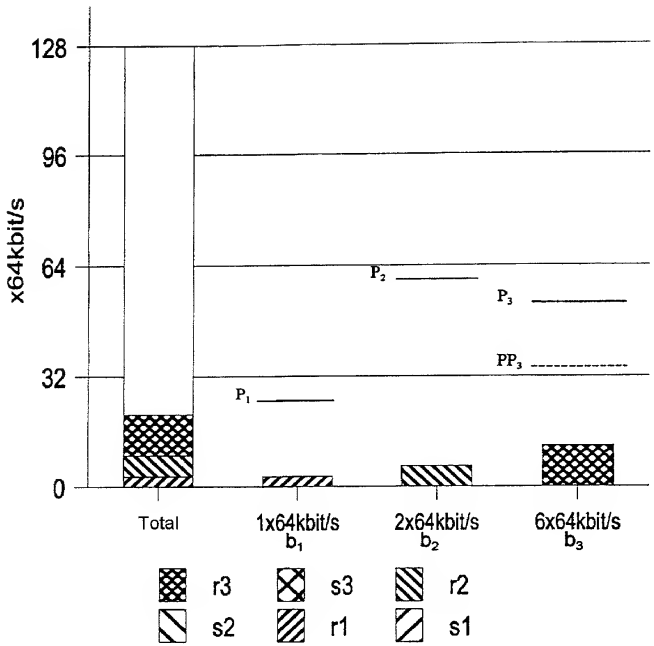
Abstract

Reserved-capacity method for digital data transmission networks and data switching center

The invention relates to a method for reserving transmission capacities and for selecting requests for data streams of different bandwidth to be transmitted in digital data transmission networks. The invention also relates to a data switching center.

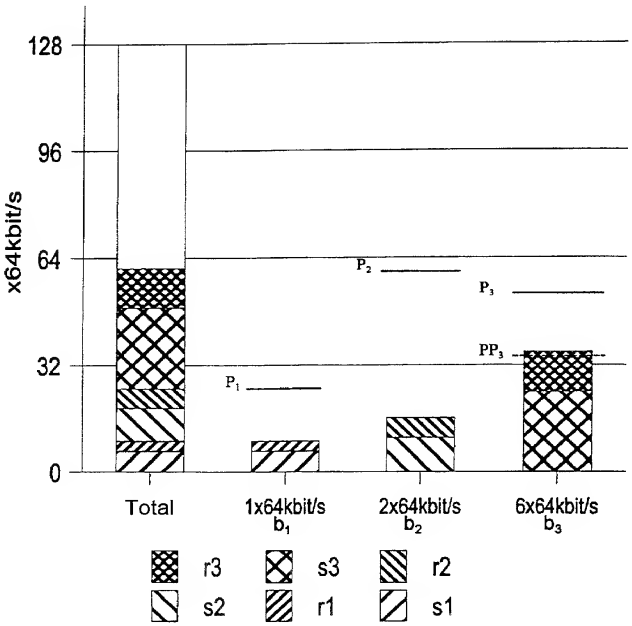
The method and the data switching center are characterized by the fact that a request for transmitting data having a certain bandwidth is accepted only if the unused data transmission capacity is greater than or equal to the sum of the reserved data transmission rates, with the exception of the reserved data transmission rate for the requesting bandwidth or bandwidth group, even after the transmission has been accepted.

Fig. 1



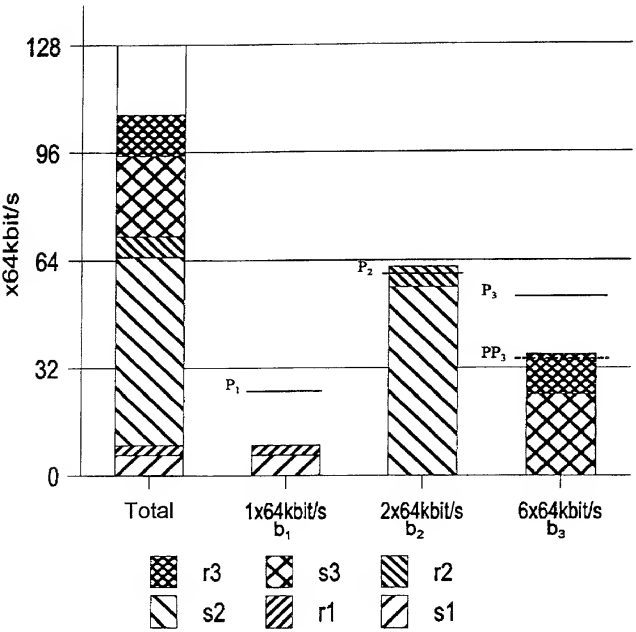
s1	0	0		
r1	3	3		
s2	0		0	
r2	6		6	
s3	0			0
r3	12			12
	107			

Fig. 2



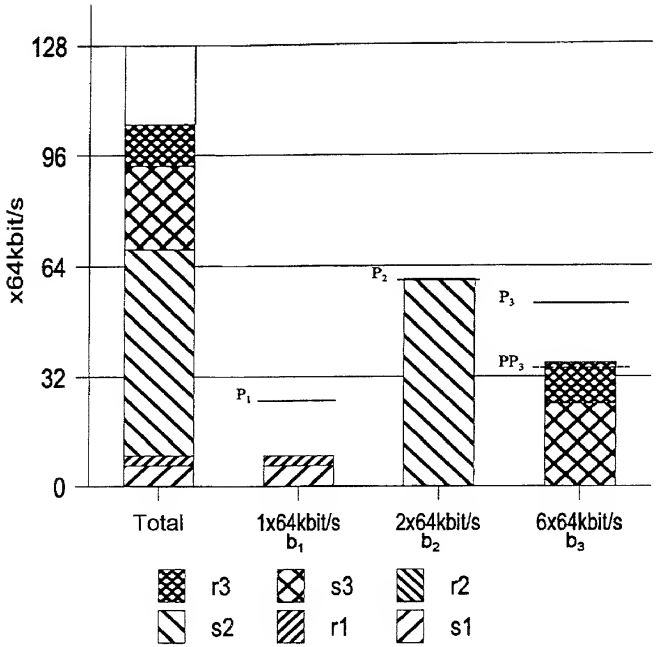
s1	6	6		
r1	3	3		
s2	10		10	
r2	6		6	
s3	24			24
r3	12			12
	67			

Fig. 3



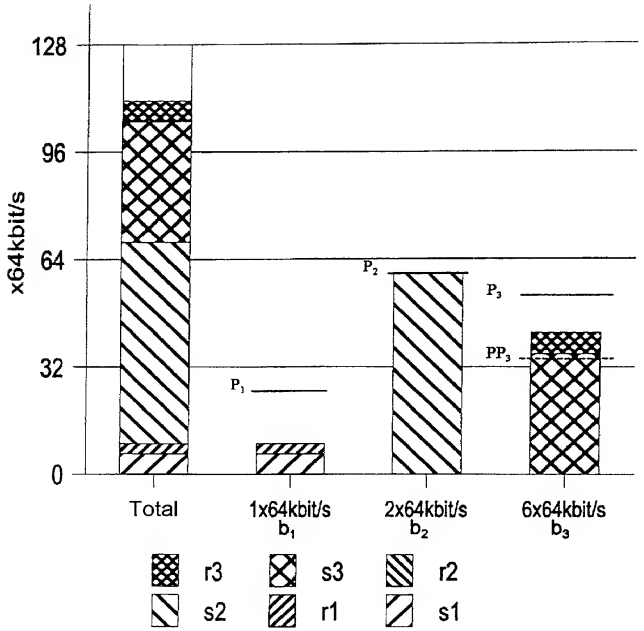
s1	6	6		
r1	3	3		
s2	56		56	
r2	6		6	
s3	24			24
r3	12			12
	21			

Fig. 4



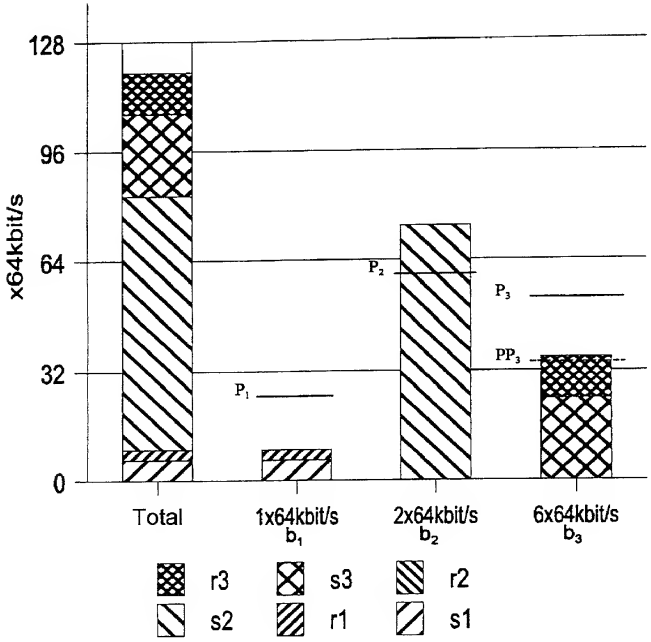
s1	6	6		
r1	3	3		
s2	60		60	
r2	0		0	
s3	24			24
r3	12			12
	23			

Fig. 5



s1	6	6		
r1	3	3		
s2	60		60	
r2	0		0	
s3	36			36
r3	6			6
	17			

Fig. 6



s1	6	6		
r1	3	3		
s2	74		74	
r2	0		0	
s3	24			24
r3	12			12
	9			

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Reservierungsverfahren in digitalen Datenuebertragungsnetzen und Datenvermittlungsstelle

Reservation method for digital data transmission networks and data switching centre

deren Beschreibung

the specification of which

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 13.01.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/EP00/00243
eingereicht wurde und am _____
abgeändert wurde (falls tatsächlich abgeändert).

(check one)
☐ is attached hereto.
☒ was filed on 13.01.2000 as
PCT international application
PCT Application No. PCT/EP00/00243
and was amended on _____
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Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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Prior foreign applications
Priorität beansprucht

			Priority Claimed	
99101001.8	EP	18.01.1999	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

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PCT/EP00/00243	13.01.2000	anhängig	pending
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D, M, Y) (Anmeldedatum T, M, J)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
_____	_____	_____	_____
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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And I hereby appoint

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Wohnsitz	Residence
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Staatsangehörigkeit	Citizenship
DE	DE
Postanschrift	Post Office Addess
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Unterschrift des Erfinders / Datum	Second Inventor's signature / Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
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(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

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